NASA TECH BRIEF
Marshall Space Flight Center

Titanium Reinforced Boron Polyimide Composite

High modulus reinforced composites are being increasingly used due to their higher strength-to-weight and stiffness-to-weight ratios. The application of optimized, oriented, filamentary composite structures in aerospace applications has been limited by low stiffness, bearing characteristics and, in some instances, temperature deterioration. The low stiffness (composite modulus) has been overcome by the development of boron and high modulus graphitic filaments. The elevated temperature characteristics have been improved by such polymers as polyimides, polybenzimidazoles, polybenzothiazoles, etc. These resin systems have not, however, been completely characterized for their processing characteristics, particularly as they apply to production type tooling. Bearing characteristics and concentrated load transfer through hard points still remain problem areas where minimum weight is required.

One good approach to reducing the weight of hard points is to incorporate lightweight metal shims to augment the strength of the composite. To minimize strains at the metal-composite interface, the component must have compatible linear coefficients of thermal expansion. A boron composite with any resin system is reasonably compatible with stainless steels, but more compatible with titanium sheet materials. Graphite composites impose problems in the incorporation of metal shims since they have a slightly negative coefficient of expansion in the longitudinal direction.

The intended use of any material imposes considerations on how it will be processed. One application of interest considered in the development effort, but not to be done under this program, was the fabrication of a conical section 9.75 meters (32 ft) in diameter at the base, tapering to 8.65 meters (28 ft) in approximately 2 meters (6 ft). The size of such a section obviously precludes the press molding of the component in one piece. It also severely limits the facilities for autoclave or hydroclave molding. Thus, the processing technique established for concentrated effort was conventional vacuum bag molding.

This program involved the development of the process technique for boron-polyimide prepreg, the lay-up and curing procedures for the prepregs when processed under vacuum bag pressure, and the development and evaluation of titanium hard points for the smooth transition of loads from the titanium attach points into the boron reinforced body of the structure. This information, after data generation, was applied to the modification of a box beam design which had previously been fabricated of boron-epoxy. After verification of the design, the component was fabricated and structurally tested at the maximum temperature capability of the system.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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